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Identification of nanocrystalline goethite in reduced clay formations: Application to the Callovian-Oxfordian formation of Bure (France)

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Abstract

The Callovian-Oxfordian (COx) clay formation in the Paris Basin (France) has been the target of many studies investigating the feasibility of deep nuclear waste disposal in a reduced clay formation. To determine the mobility of radionuclides in the host rock formation, modeling of the porewater chemistry, particularly iron solute concentrations, is necessary. Notably, this study aims to understand the supersaturation of Fe(III) oxyhydroxides given by models. Fe(III) oxyhydroxides have been identified magnetically in unpreserved Callovian-Oxfordian samples. In this study, a set of magnetic measurements are used to detect the Fe-bearing magnetic minerals present in the COx clay formation. A core sample from the borehole FOR1118, preserved from air since its collection, is the target of this study. The magnetic measurements performed show that magnetite and goethite are the main magnetic minerals (<0.2%), together with probable greigite, and occur in low concentrations. Goethite occurs as nanoparticles dispersed in the clayey matrix, and not enclosed in other minerals or in organic matter. It is unlikely that the goethite is an alteration by-product, as particular care was undertaken. This finding resolves the discrepancies between observations and previous modeling results.

Keywords: Goethite, nanoparticles, Callovian-Oxfordian clay formation, Paris Basin